



SOLAR THERMAL POWER GENERATION FOR  
TRANS KALAHARI CORRIDOR DEVELOPMENT  
PHASED TECHNOLOGY INTRODUCTION  
STEP 1  
A 500 KW SOLAR THERMAL-MORUPULA  
COAL HYBRID ELECTRIC POWER PLANT

PROJECT TEAM

Capital Sun Group, Limited

Industrial Solar Technology Corporation

Hamilton Mauer International, Incorporated

Kgalagadi Resources Development Company

## BOTSWANA PROJECT INITIATORS

Botswana Solar Thermal Electric Power Stations Team “B-STEP”

- Kgalagadi Resources Development Corporation / Solar Power
- Energy Affairs Division, Ministry of Minerals, Energy and Water Affairs
- Botswana Technology Centre
- Botswana Power Corporation
- Department of Electrical and Mechanical Services
- University of Botswana
- Department of Meteorological Services

### B-STEP Objectives

- Promote the quick arrival, assessment and deployment of Solar Thermal Electric Power technology in Botswana.
- Support existing national policy objectives relating to rural development, rural electrification and energy.
- Create a comparative advantage for Botswana in ST technology and reach Vision 2016 goal of establishing Botswana as a Center of Excellence for Solar Technology.



## WHY

# SOLAR THERMAL POWER GENERATION FOR TRANS KALAHARI CORRIDOR DEVELOPMENT

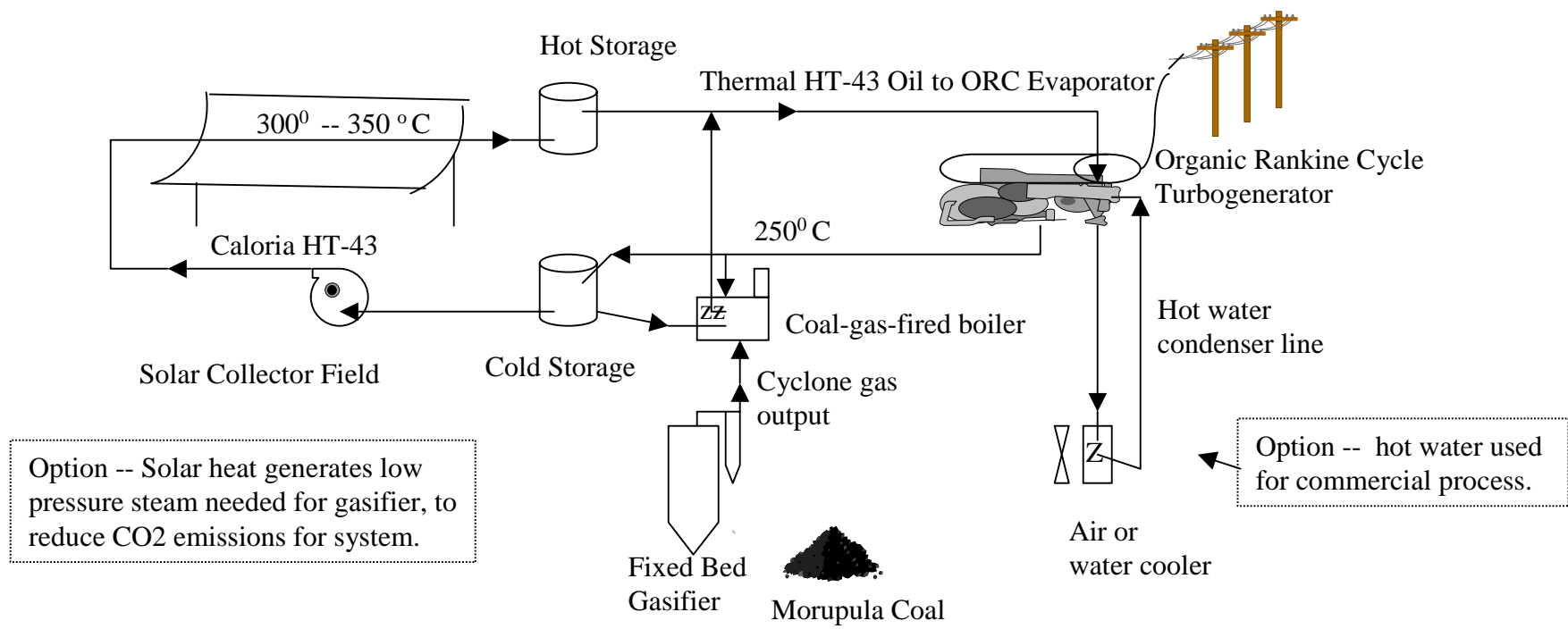
- Provide electric power for Botswana using two most abundant indigenous resources
- Reduce level of imported liquid fuels and electricity for commerce
- Introduce high temperature solar thermal technology to establish new solar manufacturing capability in Botswana, high tech employment and foster export business for Botswana
- Eliminate high cost extensions of electric grid and costly diesel power systems in remote areas

## WHAT

# SOLAR THERMAL POWER GENERATION FOR TRANS KALAHARI CORRIDOR DEVELOPMENT

## 500 KILOWATT SOLAR THERMAL HYBRID ELECTRIC POWER STATION

- Parabolic trough concentrator solar array provides high temperature thermal energy to energy storage tank and power block
- Organic Rankine cycle (ORC) turbo generator converts solar thermal energy to electricity for village and local grid
- Fixed-bed Wellman-Kalusha gasifier converts Morapulu coal and biomass to low-Btu gas to supplement solar thermal energy and create a system capable of running 24 hours per day
- System can be increased in size to a capacity from 1 to 30 megawatts for future installations and all three major components have 15 or more years of commercial installation history



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500 kWe Plant Power Schematic

## SOLAR CONCENTRATOR COMPONENT

The parabolic trough array will heat thermal oil from a cold storage tank and deliver it to a hot storage tank.

The array size will depend on a feasibility study. Two options proposed are 64,800 square feet (6020 square meters) or 72,000 square feet (6689 square meters) "module ."

The collectors will be mounted in a north-south axis.

A 64,800 square foot array would be arranged in 18 rows of 24 collector modules and have a footprint of 490 feet by 400 feet. (150 m x 122 m).

Capital Sun/IST have initially sized the solar field to provide up to 2 hours of operation at 50 % of nominal capacity.

IST's 2001 redesign employing Alanod polished aluminum reflectors will be the baseline technology.

**SOLAR HOT WATER HEATING AT THE FEDERAL  
CORRECTIONAL INSTITUTION, PHOENIX**



The solar industry combines a wide range of raw materials and manufactured parts using unskilled, skilled and professional worker inputs to produce a system that converts abundant sunshine into energy we can use in our daily lives.

## ORC POWER BLOCK

The organic Rankine cycle turbogenerator will have a nominal capacity of 500 kilowatts of power with asynchronous output at 50 Hz and 220 - 240 volts.

It will be energized with thermal oil from the solar hot storage tank, boiling a sealed internal working fluid in the ORC evaporator through a high speed turbine generator.

Feasibility analysis will determine if the ORC hot water condenser will be either air or water cooled.

Bids have been received from two suppliers, but final selection will not be made until the feasibility analysis is completed.



## MILD GASIFICATION COMPONENT

The HMI fixed-bed coal gasification system will produce clean desulfurized fuel gas from Morupula coal to operate a boiler that will heat oil from the solar thermal storage system.

A modernization of the well proven Wellman-Galusha design, it will have a 1.4 to 2.0 meter diameter fixed bed and an electrostatic precipitator for gas clean up.

The gasifier is capable of converting coal or biomass, or a mixture to clean combustible gas. Throughput estimate is 1.5 tons per hour.

The gas energy will maintain "solar power" generation during the night and cloudy days, plus will provide clean gas energy for local building or industrial use.

The gasifier creates an intermediate to base load power system for grid connection or stand alone systems to replace diesel power stations.

## WHEN

# SOLAR THERMAL POWER GENERATION FOR TRANS KALAHARI CORRIDOR DEVELOPMENT

- KRDC/Solar Power selected Capital Sun Group concept to develop in mid 2000.
- B-STEP has been reviewing project proposal since January 2001
- B-STEP created selection criteria for site and selected three villages for consideration
- B-STEP compared trough-ORC solar system with power tower and dish-Stirling technology and in February 2001 decided on trough ORC system
- Proposed project schedule calls for project initiation in June 2001

## MARKET POTENTIAL

BOTSWANA SEEKS INDEPENDENCE FROM IMPORTED SOUTH AFRICAN ELECTRICITY, WHICH ACCOUNTS FOR 50 % OF NATIONAL ELECTRICITY SUPPLY.

BOTSWANA POWER CORPORATION OBJECTIVE IS TO DISPLACE 50 TO 100 MEGAWATTS OF SOUTH AFRICAN ELECTRIC POWER IMPORTS.

### B-STEP PLAN

- 500 KW DEMONSTRATION FOR VILLAGE SELF SUFFICIENCY
- 10 MEGAWATT SYSTEM FOR GRID INTERCONNECTION
- INTRODUCTION OF SOLAR THERMAL POWER SYSTEMS FOR DIESEL "ISLAND" GRIDS IN VILLAGES OUTSIDE UTILITY SERVICE AREA

### NEAR TERM SUPPLEMENTAL MARKETS

- 300 to 500 KW ST-ORC systems for secondary schools now reliant of gasoline engine or diesel engine generator sets.
- Solar power for eco-tourism facilities remote from grids
- Solar power for craft manufacturing and meat packing agribusiness

## WHAT NEXT

# SOLAR THERMAL POWER GENERATION FOR TRANS KALAHARI CORRIDOR DEVELOPMENT

- Government of Botswana requests feasibility funding support from U.S. Trade Development Agency and other sources
- KRDC/Solar Power and Capital Sun finalize joint venture agreements and joint venture secures initial capital to conduct feasibility and final design study
- Feasibility study and system design completed
- B-STEP and joint venture team collaborate to raise capital for installation of the solar power plant as a mini-infrastructure project